AI Planning
Exercise Sheet 8

Date: December 18, 2014
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Exercise 8.1

Exercise 8.2

Definitions/Notes:

- (1) $\Pi = \langle V, I, O, \gamma \rangle$ (in FDR) is SAS$^+$ iff
  - $\forall o \in O$ have no conditional effects
  - $\forall \chi$ of $o \in O$ and γ are conjunctions of atoms
- (2) $\mathscr{T}(\Pi) = \langle S, L, T, s_0, S_\star \rangle$ is the induced transition system of $\Pi = \langle V, I, O, \gamma \rangle$ where
  - S is the set of states over V
  - $L = O$
  - $T = \{\langle s, o, t \rangle \in S \times L \times S | app_o(s) = t\}$
  - $s_0 = I$
  - $S_\star = \{s \in S | s \models \gamma\}$
- (3) For $\mathscr{T} = \langle S, L, T, s_0, S_\star \rangle$ and $\alpha : S \to S'$ (a surjective function), $\mathscr{T}^\alpha = \langle S', L, T', s'_0, S'_\star \rangle$ is the abstraction of $\mathscr{T}$ induced by α where
  - $S' = \{\alpha(s) | s \in S\}$
  - $T = \{\langle \alpha(s), \ell, \alpha(t) \rangle | \langle s, \ell, t \rangle \in T\}$
  - $s'_0 = \alpha(s_0)$
  - $S'_\star = \{\alpha(s) | s \in S_\star\}$
- (4) $P \subseteq V$ is a pattern, $\Pi|_P$ denotes Π restricted to the variables in P
- (5) π_P is the projection $S \to S'$ for P, $\pi_P(s) := s|_P$, $\mathscr{T}^{\pi_P}$ denotes the transition system induced by π_P
- (6) two transition systems $\mathscr{T}$ and $\mathscr{T}'$ are graph-equivalent ($\mathscr{T} \overset{G}{\sim} \mathscr{T}'$) if there exists a bijective function $\phi : S \to S'$ such that
  - $\phi(s_0) = s'_0$
  - $s \in S_\star$ iff $\phi(s) \in S'_\star$
  - $\langle s, \ell, t \rangle \in T$ for *some* $\ell \in L$ iff $\langle \phi(s), \ell', \phi(t) \rangle \in T'$ for *some* $\ell' \in L'$

(a) to show: $\mathscr{T}(\Pi|_P) \overset{G}{\sim} \mathscr{T}(\Pi)^{\pi_P}$ if Π
- is an SAS$^+$ planning task
- is not trivially unsolvable

- has no trivially inapplicable operators

In terms of the definitions/notes above: (6) holds between:
- (4), then (2)

and
- (2), then (5) — the latter being a special case of (3)

$\mathscr{T}(\Pi|_P)$:
The difference to $\mathscr{T}(\Pi)$ in this case is V of $\Pi|_P$, which affects S directly and T and $S_\star$ indirectly. S will not include states over $V \setminus P$. T and $S_\star$ will be restricted accordingly.

$\mathscr{T}(\Pi)^{\pi_P}$:
The difference to $\mathscr{T}(\Pi)$ in this case is that after getting $\mathscr{T}$ the latter is abstracted by means of π_P. This means for all states $s' \in S'$ of $\mathscr{T}^{\pi_P}$, $s \in S$ of $\mathscr{T}$: $s' = s|_P$. In other words, information about variables $v \notin P$ will be discarded in all s'. Again, T and $S_\star$ will be restricted accordingly.

In both cases all information about variables not in P is discarded. Performing this step by means of (4) before (2) or by means of (5) after (2) does not violate (6).

(b) Wild guess: replacing effect conditions in $o \in O$ with $\top$ causes problems with the third (see (6) above) condition of graph-equivalence dealing with transitions.